

**SOLID WASTE PERMITTING  
SUBMISSION INSTRUCTION NO. 13**

**LANDFILL GAS MANAGEMENT, REMEDIATION, and ODOR PLANS  
FOR SOLID WASTE DISPOSAL FACILITIES**

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Developed by:

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## **TABLE OF CONTENTS**

<b>I.</b>	<b>LANDFILL GAS MANAGEMENT PLAN.....</b>	<b>3</b>
A.	INTRODUCTION .....	3
B.	GAS MONITORING STANDARD.....	3
C.	LANDFILL GAS CONTROL.....	3
1.	<i>Peak Flow</i> .....	3
2.	<i>Gas Venting &amp; Collection System(s)</i> .....	4
D.	PERIMETER MONITORING NETWORK.....	4
1.	<i>Description of Migration Potential</i> .....	4
2.	<i>Location</i> .....	5
3.	<i>Spacing</i> .....	5
4.	<i>Depth</i> .....	5
5.	<i>Monitoring Probe Construction</i> .....	6
E.	STRUCTURE MONITORING .....	6
F.	SAMPLING & ANALYSIS .....	7
G.	MONITORING FREQUENCY .....	7
H.	RESPONSE REQUIREMENTS .....	8
1.	<i>Action Level Exceedance</i> .....	8
2.	<i>Compliance Level Exceedance</i> .....	8
I.	RECORDKEEPING .....	8
<b>II.</b>	<b>LANDFILL GAS DEMONSTRATION.....</b>	<b>10</b>
A.	TYPES OF WASTE.....	10
B.	BARRIERS TO MIGRATION .....	10
C.	LANDFILL GAS DEMONSTRATION.....	10
<b>III.</b>	<b>LANDFILL GAS REMEDIATION PLAN .....</b>	<b>11</b>
A.	INTRODUCTION .....	11
B.	MONITORING AFFECTED PROBES/STRUCTURES .....	11
C.	GAS CONTROL MEASURES .....	11
1.	<i>Gas Control Description</i> .....	11
2.	<i>Remediation Standard</i> .....	12
3.	<i>Coordination with Air Program</i> .....	12
4.	<i>Implementation Schedule</i> .....	12
D.	RETURN TO COMPLIANCE.....	12
<b>IV.</b>	<b>ODOR MANAGEMENT PLAN .....</b>	<b>13</b>
A.	INTRODUCTION .....	13
B.	ODOR CONTACT.....	13
C.	HANDLING ODOR COMPLAINTS .....	13
1.	<i>Documenting the complaint</i> .....	13
2.	<i>Facility Investigation</i> .....	13
3.	<i>Remedial Measures</i> .....	14
D.	ANNUAL PLAN REVIEW .....	14
	<b><u>ATTACHMENT A.....</u></b>	<b><u>15</u></b>

## **I. LANDFILL GAS MANAGEMENT PLAN**

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A Landfill Gas Management Plan (LFGMP) is required for all solid waste disposal facilities and should be submitted with the Part B Application or Part B Modification Application as Attachment IX to DEQ Form SW PTB. VSWMR [9 VAC 20-81-130](#).K. provides for an exception to this requirement for CDD and Industrial Landfills that have demonstrated that gas formation is not a concern at their facility. Such demonstrations are discussed in [Section II](#) below, and should be provided in Attachment IX in lieu of a LFGMP, if applicable. [9 VAC 20-81-200]

The LFGMP shall also address the requirements of [40 CFR 60 Subpart Cc \(60.33c\)](#) and [Subpart WWW \(60.750\)](#) (Standards of performance for new and guidelines for control of existing municipal solid waste landfills) and [9 VAC5-40-5800](#), as applicable. This submission instruction does not address the information required for complying with these provisions; however, documents prepared to meet these provisions will be reviewed by the appropriate DEQ Regional Office Air Program personnel and shall be incorporated into the LFGMP upon completion of the review.

**Format** The format used for the LFGMP should encourage clear analysis and presentation of the proposed system for the control and detection of landfill gas. The LFGMP should start with a title page and table of contents followed by the following sections and discussions. The title page should identify the facility name and permit number, the permit applicant, document date, and document preparer information. In addition, the header or footer of each page should include the facility name, permit number, document title, revision date, and page number.

### **A. Introduction**

Provide a brief history of landfill gas monitoring activities performed and reference that the plan has been prepared in accordance with the VSWMR, [§9 VAC 20-81-200](#).

### **B. Gas Monitoring Standard**

Indicate the landfill gas monitoring and control system designed for the solid waste disposal facility has been provided for the protection of public health and safety and the environment and will ensure that landfill gas generated at the facility during the periods of operation, closure, and post-closure care will not exceed the methane gas concentrations specified in [§ 9 VAC 20-81-200](#).A.1. [9VAC20-81-140.A.5. and 200.A.1.]

### **C. Landfill Gas Control**

Provide a description of the landfill gas control features installed or planned to be installed to protect the landfill cap and prevent migration of landfill gas into structures or beyond the facility boundary. [9 VAC 20-81-200]

#### **1. Peak Flow**

Estimate the gas generation rate at the point of expected maximum. Describe data sources and methods used to make the calculations. Provide copies of calculations and/or modeling results as an appendix to this plan.

## 2. **Gas Venting & Collection System(s)**

Discuss the design and spacing of landfill gas vents/wells, the associated pipe network or extraction/collection equipment. Discuss the pipe type, strength, and size to be used, referencing the Technical Specifications as appropriate and providing supporting calculations as an appendix to this plan.

Gas vents are typically drilled to a depth of approximately 80 percent of the depth of waste at all locations, but can be other depths based on the extraction system design. Vents/extraction wells should be constructed with slotted or perforated pipe and surrounded by a granular material to facilitate collection of gases. The vents/extraction wells must be constructed in a manner compatible with the installation of the final cover system. Features of the gas venting and collection system that should be discussed include:

### a. *Passive Gas Vents*

A passive venting system will allow for the collection of landfill gases from the waste mass and venting of the gases under atmospheric conditions; the effectiveness of a passive venting system is dependent on climatic conditions. Typically, a minimum of 1 passive vent per acre should be installed as a starting point.

### b. *Active Gas Wells*

An active venting system would include a mechanical device (a blower) to ensure effective collection and venting of gas under all conditions. Active gas extraction well spacing should be determined through pump tests conducted in accordance with industry standards.

### c. *Active Gas Collection System*

A gas collection system is another component of an active gas extraction system. The collection system may consist of vertical extraction wells (similar to vents), a lateral collection system, or a combination of the two designs. A collection system incorporates piping, valves, sampling locations and mechanical blowers.

### d. *Active Gas Destruction System*

Describe the flare system, landfill gas to energy plant, or other equipment used to manage landfill gas. These systems may be installed voluntarily by the facility or as required under the Clean Air Act (40 CFR 60.33c and 40 CFR 60.750) and the Emission Standards for Municipal Solid Waste Landfills ([9 VAC 5-40-5800](#)).

## D. **Perimeter Monitoring Network**

### 1. **Description of Migration Potential**

Discuss the probable gas migration paths, accounting for site specific characteristics including, but not limited to:

- Local soil and rock conditions;
  - Hydrogeological and hydraulic conditions surrounding the landfill;
  - Locations of buildings and structures relative to the waste deposit area;
  - Adjacent land use, and inhabitable structures within 1,000 feet of the landfill facility boundary;
  - Manmade pathways, such as underground construction; and
  - The nature and age of waste and its potential to generate decomposition gas.
- [9 VAC 20-81-200.B.1. and B.2.]

## **2. Location**

Monitoring wells shall be located at or near the facility boundary. The applicant may propose an alternate boundary closer to the waste mass requiring fewer wells, based on the knowledge of site factors. If an alternate boundary is proposed, the plan must show where the applicant will install additional monitoring wells closer to the facility boundary, or how the operator will implement gas control procedures when compliance levels are exceeded at the alternate boundary. The entire perimeter of the landfill may not warrant the installation of monitoring wells. In this case, the operator shall demonstrate to the satisfaction of the Department that gas migration could not occur along a specific pathway owing to geologic or hydraulic barriers, and that no inhabitable structure or other off-site use of property within 1,000 feet of the landfill facility boundary are threatened by gas migration.

The location of the perimeter gas monitoring network at the facility shall be provided on the Site Monitoring Plan provided in Part B Attachment III. For an existing facility that does not have a complete set of Design Plans provided as Part B Attachment III, a Landfill Gas Site Monitoring Plan should be provided as an appendix to this LFGMP.

## **3. Spacing**

Show the spacing of all gas monitoring wells. Justify the proposed plan based upon, but not limited to, the nature of the structure to be protected and its proximity to the refuse. Wells shall be spaced to align with gas permeable structural or stratigraphic features, such as dry sand or gravel, off-site or on-site structures, and areas of dead or stressed vegetation that might be due to gas migration. Generally, the lateral spacing between adjacent monitoring wells should not exceed 250 feet, unless the applicant shows that such spacing would be unwarranted based on the site-specific factors. The spacing between the probes shall be reduced as necessary to protect persons and structures threatened by decomposition gas migration.

## **4. Depth**

The depth of the monitoring well bore shall at least equal the maximum depth of refuse as measured within 1,000 feet of the monitoring point. When conditions limit the practicality or do not warrant the well bore depth criteria, the applicant may

demonstrate that probes located at alternate depths are sufficient to detect migrating decomposition gas and provide protection to public health and safety, and the environment. All probes shall be installed above the permanent low seasonal water table, above and below perched ground water, and above bedrock. The specified depths of monitoring probes within the well bore shall be adjusted, based on geologic data obtained during drilling, and probes shall be placed adjacent to soils which are most conducive to gas flow. Normally, the number and depths of monitoring probes within the well bore should be installed in accordance with the following criteria:

- A shallow probe installed 5 to 10 feet below the surface;
- An intermediate probe installed at or near half the depth of the well bore; and
- A deep probe at or near the depth of the well bore.

When the depth of the well bore does not exceed 30 feet, the applicant may reduce the number of probes to two, with one probe located in the shallow zone as indicated above, and the other located adjacent to permeable soils at or near the depth of the well bore.

Provide a table listing the probe name / identification number and probe surface elevation and depth.

#### 5. **Monitoring Probe Construction**

Provide a general description of the monitoring probe construction, referencing the Technical Specifications for landfill gas probe construction as provided in Part B Attachment VII. For an existing facility that does not have a complete set of Technical Specifications provided as Part B Attachment VII, technical specifications relating to the design of landfill gas probes should be provided as an appendix to this LFGMP.

Boring / As-Built logs, should be included as an appendix to this LFGMP and include the names of the person(s) logging the hole, the probe material and depth, extent and type of filter pack, thickness and material used for seals, extent and materials used for backfill, size and interval of perforations, and a description of any shutoff valves or covers.

#### E. **Structure Monitoring**

Include a description of the on-site landfill structures, both adjacent to and on top of the waste mass, that will be monitored for landfill gas. Structures include, but not are limited to buildings, subsurface vaults, utilities or any other areas where potential gas buildup would be of concern. For each building identified, indicate the areas within that will be monitored. Areas of the structure where gas may accumulate may include, but are not limited to areas in, under, beneath and around basements, crawl spaces, floor seams or cracks, and subsurface utility connections. [9 VAC 20-81-200.B.1.]

#### F. Sampling & Analysis

Specify the equipment and calibration and monitoring procedures to be used to measure the concentrations of methane gas both within the perimeter monitoring network and on-site structures. [9 VAC 20-81-200.A.]

Field measurements are usually collected with a portable methane meter, explosimeter, or organic vapor analyzer. Instruments of the hot-wire Wheatstone bridge type (i.e., catalytic combustion) directly measure combustibility of the gas mixture withdrawn from the probe. The thermal conductivity type meter is susceptible to interference as the relative gas composition, and therefore the thermal conductivity changes. Field instruments should be calibrated prior to measurements and should be rechecked after that day's monitoring activity. Gas samples also may be collected in glass or metal containers for laboratory analysis. Laboratory measurements, with organic vapor analyzers or gas chromatographs, should be used to confirm the identity and concentrations of gas.

The facility's proposed monitoring procedure will vary depending on the equipment selected; however, the procedure should be sure to include an initial measurement of the probe pressure at each probe depth prior to sampling. The procedure can include purging of a maximum of two probe casing volumes as determined based on the volume of the probe casing and the sample pump flow rate. In this situation, the maximum methane concentration should be recorded along with the concentration of oxygen and carbon dioxide. If the methane concentration is slowly increasing as the probe is pumped, the concentration at two probe volumes should be recorded for the compliance reading. The objective behind this method is to record the conditions of the gas around the probe and not gasses trapped in the probe casing or gases that can be pulled into the probe via the purging process.

On-site structures may be monitored using permanently installed monitoring probes, gas surveys, or continuous monitoring systems. Structures located on top of the waste mass should be monitored on a continuous basis. When practical, structures shall be monitored after they have been closed overnight or for the weekend to allow for an accurate assessment of gas accumulation. For safety purposes, oxygen concentrations should be monitored in conjunction with the methane monitoring for structures.

#### G. Monitoring Frequency

The frequency of monitoring should be sufficient to detect landfill gas migration based on subsurface conditions and changing landfill conditions such as partial or complete capping, landfill expansion, gas migration control system operation or failure, construction of new or replacement structures, and changes in landscaping or land use practices. The rate of landfill gas migration as a result of these anticipated changes and site specific conditions provides the basis for establishing monitoring frequency. This plan shall justify the monitoring frequency selected; however, at a minimum, monitoring should be conducted quarterly. [9 VAC 20-81-200.B.4.]

## H. Response Requirements

### 1. Action Level Exceedance

Indicate the facility's response to concentrations of methane detected at or above the action level (25% of the methane lower explosive limit (LEL) in facility structures or 80% LEL at the facility boundary). At a minimum, the facility's response shall include:

- Taking all immediate steps necessary to protect public health and safety (safety precautions should include evacuation of occupied structures, if affected; notifying local fire/safety officials of potential landfill gas migration; and coordinating for off-site monitoring of structures located within 1,000 feet of the facility boundary); and
- Notifying the department in writing within 5 working days of learning the action level has been exceeded and indicating what has been done or is planned to be done to resolve the problem.

[9 VAC 20-81-200.C.1.]

### 2. Compliance Level Exceedance

Indicate the facility's response to concentrations of methane detected at or above the compliance level (25% LEL in facility structures or 100% LEL at the facility boundary). At a minimum, the facility's response should include:

- Taking immediate steps to protect public health and safety as indicated for an action level exceedance;
- 24-hour oral notification of the methane exceedance;
- 5-day written notification of the methane exceedance; and
- Increasing the gas monitoring frequency of non-compliant probes and/or structures and those probes/structures immediately adjacent (Implementation of weekly monitoring should be performed unless an alternate frequency is approved by the Department);
- Implementing and submitting a Landfill Gas Remediation Plan, as discussed in [Section III](#) below, to the Department for review and incorporation into the facility's permit.

[9 VAC 20-81-200.C.2.]

## I. Recordkeeping

Indicate the parameters to be monitored and recorded during each landfill gas monitoring event. Records should include:

- Date, time, barometric pressure, atmospheric temperatures, general weather and land surface conditions, and probe pressures (time, barometric pressures,



atmospheric temperatures and weather/land surface conditions should be noted at the start and end of each day's monitoring event);

- Names of sampling personnel, apparatus utilized, and a brief description of the methods used;
- A number system to correlate monitoring results to a corresponding probe location;
- The initial and steady-state concentrations of methane as measured at each probe and within each on-site structure; and
- Monitoring and design records for any gas remediation or control system.

[9 VAC 20-81-200.A.1. and 200.E.]

## II. LANDFILL GAS DEMONSTRATION

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This section applies only to CDD and Industrial Landfills that wish to demonstrate that gas formation is not a concern at their facility. The demonstration as discussed in this section should be provided as Attachment IX to DEQ Form SW PTB in lieu of a LFGMP. A successful demonstration will present information on one or more of the following topics in relation to the facility. [9 VAC 20-81-130.K.]

**Format** The format used for the Landfill Gas Demonstration should present clear and concise information regarding the site specific features that indicate landfill gas will not be a concern at the facility. The Demonstration should start with a title page and table of contents followed by the following sections and discussions. The title page should identify the facility name and permit number, the permit applicant, document date, and document preparer information. In addition, the header or footer of each page should include the facility name, permit number, document title, revision date, and page number.

### A. Types of Waste

Provide a description of the types of waste accepted and provide information on waste decomposition.

### B. Barriers to Migration

1. To make the claim that there is a hydrogeologic barrier to prevent landfill gas migration, provide information on site hydrogeology and depth of waste in relation to depth of groundwater, referencing information provided in the Part A application as applicable.
2. For sites where the elevation of the facility boundary is below the depth of waste, provide a site plan showing the depth of waste and topographic contours.

### C. Landfill Gas Demonstration

Provide a plan to assess future landfill gas generation and migration at the landfill. Indicate monitoring procedures to be employed at some point after the start of landfilling to determine whether waste decomposition is generating landfill gas. Also, provide proposed locations for perimeter gas monitoring probes and a monitoring frequency to check for landfill gas migration.

### III. LANDFILL GAS REMEDIATION PLAN

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The Landfill Gas Remediation Plan (LFGRP) should be submitted in accordance with the requirements of [9 VAC 20-81-200.C.](#) with the Part B Modification Application as Attachment IX to DEQ Form SW PTB. A LFGRP is only required for those facilities found to exceed the landfill gas compliance levels at one or more perimeter boundary probes or within landfill structures.

**Format** The format used for the LFGRP should encourage clear analysis and presentation of the proposed plans for landfill gas remediation. The LFGRP should start with a title page and table of contents followed by the following sections and discussions. The title page should identify the facility name and permit number, the permit applicant, document date, and document preparer information. In addition, the header or footer of each page should include the facility name, permit number, document title, revision date, and page number.

#### A. Introduction

Provide an introduction that describes the circumstances leading up to submission of the LFGRP. The introduction should provide a history of the exceedance, a summary of the immediate actions taken in response to the compliance level exceedance and indicate the affected probe(s) and/or structure(s). [9 VAC 20-81-200.C.2.]

#### B. Monitoring Affected Probes/Structures

Summarize the monitoring performed in response to the initial landfill gas compliance level exceedance. Discuss trends in the data, noting any changes made to the landfill gas venting, collection, or perimeter monitoring system that may have affected the monitoring results. [9 VAC 20-81-200.B.4. and C.2.]

#### C. Gas Control Measures

##### 1. Gas Control Description

Provide a description of the proposed gas control measures to be implemented to address the compliance level exceedance. It is beneficial to provide a phased approach to landfill gas control, so that additional landfill gas remediation plans are not necessary if the proposed remediation is unsuccessful.

Gas control measures to protect structures, and public health and safety, could include one or more of the following: flexible membrane liners, active collection systems, passive collection systems designed to be upgraded to an active system, alarms, ignition source control, utility collars installed within structures and outside in trenches, and ventilation. Gas controls such as perimeter air injection systems or passive systems, including cutoff trenches, slurry walls and vent trenches are some of the mechanisms used to prevent the migration of landfill gas. Passive systems must be installed to the depth of permanent low seasonal ground water or keyed into a low permeability layer below the limit of migration. Impermeable

geomembranes are used with vent trenches to create a barrier to gas migration. [9 VAC 20-81-200.C.2.]

## 2. Remediation Standard

Discuss how the construction and operation of the proposed control facilities at the facility will:

- Prevent methane accumulation in on-site structures;
- Reduce methane concentrations at monitored property boundaries to below compliance levels; and
- Provide for the collection and treatment and/or disposal of decomposition gas condensate produced at the surface. Note that condensate generated from gas control systems may be recirculated into the landfill provided the facility complies with the liner and leachate control systems design requirements of [9 VAC 20-81-130.J.1.a.](#) or [b.](#) and [9 VAC 20-81-210.D.](#) or the facility has an approved RDD Plan in accordance with [9 VAC 20-81-600.F.7.](#)

[9 VAC 20-81-200.C.3.]

## 3. Coordination with Air Program.

If required, reference the systems to be designed and constructed to control emissions of nonmethane organic compounds under the Clean Air Act or [9 VAC 5-40-5800](#). [9 VAC 20-81-200.C.4.]

## 4. Implementation Schedule

Provide a schedule that specifies timeframes for implementing the proposed remedial actions, evaluating the effectiveness of such remedial actions, and milestones for proceeding with additional phases of the remediation plan, if necessary. The schedule should be provided in tabular form. Proposed timeframes should be based on the facility's proximity to sensitive receptors and the concentrations of methane detected. [9 VAC 20-81-200.C.2.]

## D. Return to Compliance

Provide a return to compliance monitoring frequency. As indicated in [Section I.H.2.](#) above, weekly monitoring of the noncompliant probe/structure and those probes/structures immediately adjacent is recommended. In order to return to the required minimum quarterly monitoring schedule, it is recommended that the facility continue to implement weekly monitoring of the affected probe/structure subset until three consecutive weekly monitoring events indicate methane has decreased below compliance levels. The facility should then continue with monthly monitoring of the probe/structure subset until three consecutive monthly monitoring events indicate methane has stayed below compliance levels. At this point, the facility should return to quarterly monitoring. An alternate gas monitoring frequency may be approved based on site specific conditions. [9 VAC 20-81-200.C.4.]

#### IV. ODOR MANAGEMENT PLAN

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An Odor Management Plan (OMP) should be submitted in accordance with the requirements of 9 VAC 20-81-200.D. and maintained in the facility's Operating Record. An OMP is only required for those facilities found to have created an odor nuisance or hazard under normal operating conditions and upon notification from the department. OMPs developed in accordance with the Virginia Air Regulations ([9 VAC 5-40-140](#), [9 VAC 5-50-140](#), or other state air pollution control regulations) will suffice for this plan.

**Format** The format used for the OMP should encourage clear analysis and presentation of the proposed plans for odor management. The OMP should start with a title page and table of contents followed by the following sections and discussions. The title page should identify the facility name and permit number, the permit applicant, document date, and document preparer information. In addition, the header or footer of each page should include the facility name, permit number, document title, revision date, and page number.

##### A. Introduction

Provide an introduction that describes the circumstances leading up to submission of the OMP. The introduction should provide a summary of the odor complaint(s) received and the immediate actions taken in response. [9 VAC 20-81-200.D.]

##### B. Odor Contact

Indicate the name, address, and telephone number of the person or office that citizens can notify about odor concerns. [9 VAC 20-81-200.D.2.]

##### C. Handling Odor Complaints

Specify procedures for handling odor complaints from citizens. [9 VAC 20-81-200.D.1.]

###### 1. Documenting the complaint

Provide a form for landfill personnel to use to document complaints. An example form is provided as [Attachment A](#).

###### 2. Facility Investigation

Discuss steps landfill personnel will take in response to the complaint received. Such steps should include:

- Using equipment or olfactory senses to monitor the odor complaint location, the facility boundary point closest to the complaint location area, the working face, and any other potential odorous areas. Locations selected for monitoring should take into account the weather conditions at the time of the complaint;
- Placing documentation in the operating record describing the response(s) taken to odor complaints received;
- Notifying the DEQ Regional Office within 24 hours of the complaint.

- Follow-up with the complainant to provide a summary of the work completed since the complaint was logged.

### 3. Remedial Measures

Discuss the potential remedial measures to be employed by the facility once the source of the odor has been identified. Such remedial actions could include:

- Evaluate the incoming waste stream for odor producing materials and reduce the amount of the odor producing material so identified or modify operations to improve handling;
- Apply six inches of soil cover or approved alternate cover material to exposed working areas;
- Apply an odor reducing/controlling agent;
- Repair leachate seeps; or
- Make any necessary repairs to the leachate management system.

#### D. Annual Plan Review

The OMP shall be reviewed by appropriate facility personnel annually and updated as necessary. Procedures for documenting this review and update can be found in [Guidance Memo 01-2011A: Implementation of New Operations Manual Requirements](#). [9 VAC 20-81-200.D.3.]

### **Attachment A**

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#### **Odor Complaint Tracking Form**

**ODOR COMPLAINT FORM**

**FACILITY NAME:** \_\_\_\_\_  
**FACILITY ADDRESS:** \_\_\_\_\_  
\_\_\_\_\_

**DATE:** \_\_\_\_\_  
**TIME:** \_\_\_\_\_

**RECEIVED BY:** \_\_\_\_\_

**Contact Information of Caller**

Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Address 2: \_\_\_\_\_  
Phone: \_\_\_\_\_  
Email: \_\_\_\_\_

**Odor Information**

Date Detected: \_\_\_\_\_  
Time Detected: \_\_\_\_\_  
Location Detected: \_\_\_\_\_

**Description of Complaint**

**Type of Odor:** \_\_\_\_\_  
\_\_\_\_\_

**Intensity of Odor:** \_\_\_\_\_  
\_\_\_\_\_

**Weather Conditions when odor was detected:** \_\_\_\_\_  
\_\_\_\_\_

**Have odors been noticed at this location in the past?** \_\_\_\_\_  
\_\_\_\_\_

**Weather Conditions at the time odors were detected (based on weather monitoring station or internet resources):**

Wind Direction & Speed: \_\_\_\_\_ Rainfall: \_\_\_\_\_ Temperature: \_\_\_\_\_  
Barometric Pressure: \_\_\_\_\_ Humidity: \_\_\_\_\_

**Follow-up Contact with Caller**

Was follow-up contact made with the caller?

If yes, answer the following questions:

When was contact made? Date: \_\_\_\_\_ Time: \_\_\_\_\_

Who made contact? \_\_\_\_\_

How was contact made? (Letter, Phone Call, E-mail, etc.)

What issues were discussed with the caller?

Description of Corrective Measures: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_